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DIETS OF MULE DEER, PRONGHORN ANTELOPE, CALIFORNIA BIGHORN SHEEP, DOMESTIC CATTLE AND FERAL HORSES, IN NORTHWESTERN NEVADA

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Report to

Cooperators by

Michael C. Hansen

13 September 1982

DIETS OF MULE DEER, PRONGHORN ANTELOPE, CALIFORNIA BIGHORN SHEEP, DOMESTIC CATTLE AND FERAL HORSES, IN NORTHWESTERN NEVADA

The Sheldon National Wildlife Refuge (SNWR) in northwestern Nevada was originally established to protect rangelands important to the pronghorn antelope (Antilocapra americana). In addition, the area is presently managed for 2 other endemic big game animals, mule deer (Odocoileus hemionus) and California bighorn sheep (Ovis canadensis californiana), and 2 exotic ungulates, feral horses (Equus caballus) and domestic cattle (Bos taurus).

One prerequisite for managing a rangeland for more than 1 herbivore is a thorough knowledge of the seasonal diets of each species inhabiting the range. Only through knowledge of the feeding habits of each animal species can range utilization and range condition and trend information be accurately interpreted, or proper forage quantities be allocated. The objective of this study was to determine year-round diets for all 5 ungulates present in the study area.

Field work for this project took place between July 1979 and June 1980. It was conducted as an accessory project in conjunction with a status and habitat preference project on the bighorn sheep, resident on SNWR (Hansen 1982).

While the majority of the funding of this project was provided by the U.S. Fish and Wildlife Service several other organizations also

provided financial support, including The National Rifle Association, The Foundation for North American Wild Sheep, Wild Horse Organized Assitance, and the Oregon State Agricultural Experiment Station.

STUDY AREA

The study area included Gooch Table, upper Virgin Valley, western Rock Spring Table, Alkali Canyon, Devaney Peak, the Fish Creek Mountains, and all intervening areas; however, the majority of the study was conducted in the Hell Creek Basin (Figure 1). The area was typified by extensive tables of volcanic origin cut by several watercourses, many of which were intermittent. Elevation varied from 1580 m to 2010 m. Extensive cliffs bordered some of the watercourses, while low rimrock was found at the upper edges of the tables.

The area was arid, with precipitation occurring principally as thunderstorms from late spring to early fall, and as snow during the balance of the year. For the period 1968 to 1979, precipitation ranged between 13.5 and 28.6 cm annually, and averaged 20.1 cm (U.S. Weather Bureau 1968-79). Average daily temperatures varied between -3 C in January and 21 C in July.

SNWR lay within the High Desert Resource Province (Anderson 1978). The vegetation consisted principally of sagebrush (Artemisia spp.) communities with an understory of bunchgrasses and forbs. Several deciduous woody species including quaking aspen (Populus tremuloides), willow (Salix spp.), and chokecherry (Prunus virginiana), were found near permanent water. Curlleaf mountain mahogany (Cercocarpus

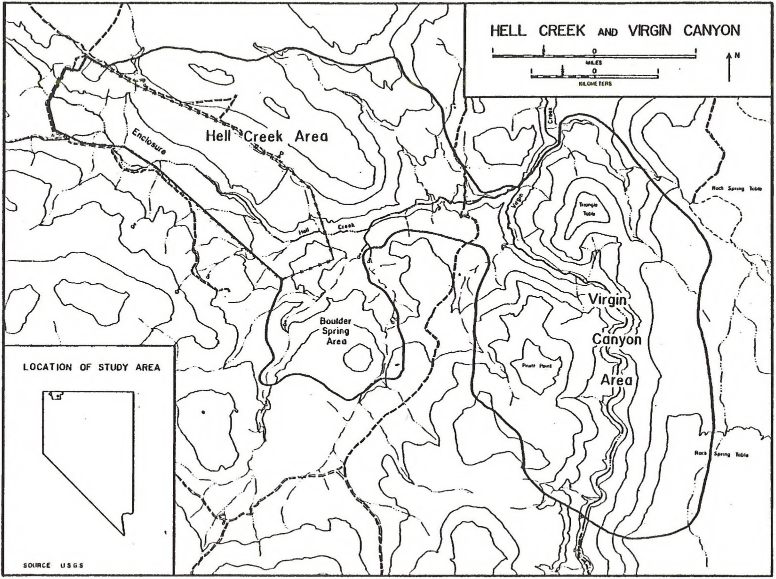

Figure 1. Study area including: 300 foot contour lines (⁀), springs (♀), drainages (⁀⁀), roads (═), enclosure fence (✶✶✶), and outer limits of sheep use (⁀).

ledifolius) occurred on rocky areas at higher elevations. Anderson (1978) gave descriptions of the plant communities found on SNWR under pristine conditions.

MATERIALS AND METHODS

Determination of dietary components was done by micro-histological analysis of fecal samples at the Food Habits Laboratory, Texas Tech University. Fecal samples were collected approximately at 2 week intervals between July 1979 and June 1980. Twenty samples from each month represented the diet for each herbivore species except bighorn. Thirty samples, roughly 15 each from the ewe/lamb and ram bands, represented the bighorn sheep diet each month. Two exceptions to this sampling scheme occurred in fall and winter. Cattle were removed from the range for the winter, consequently no samples were available from January to April. In addition, the November and December samples were from a small number of trespass cattle in upper Virgin Valley. The second exception involved bighorn sheep and occurred between October and February. During these months, the rams moved from their primary range in Virgin Canyon to join the ewes in Hell Creek for the rut, and all 30 samples were collected from large groups with a preponderance of ewes.

Each sample consisted of approximately 80 ml of fecal material collected from a single fecal deposit. All samples were preserved in a solution of 70% ethanol. Most samples were located following direct observation of animals. Other characteristics used in identification of feces included, associated tracks, type of habitat where found, external visual characteristics, and odor. Only when 3 or more identification characteristics were available, and all agreed, were feces used as samples. Most samples were shipped to the lab within 1 month of collection, but some, particularly those from antelope and horse, were stored in ethanol for up to 2 years before laboratory analysis while awaiting funding.

The plant reference set consisted of 160 specimens collected on the study area: 29 grass and grass-likes, 108 forbs, and 23 shrubs. The initial set included 120 specimens. An additional 40 forbs were included after the spring of 1980, when they became available. Therefore, only the antelope and horse samples, and the deer, sheep, and cattle samples from April to June were analyzed using the entire 160 specimen reference set.

Analyses at the Food Habits Lab were similar to those of Sparks and Malechek (1968), and involved inspection of 20 microscope fields per sample for frequency of occurrence. Frequency was then converted to relative density by the formula derived by Fracker and Brischle (1944).

In compiling the data, seasons were determined on the basis of plant phenology for the SNWR, and thus did not follow calendar seasons or constitute equal time periods. July, August, and September were considered summer. Fall included October and November. December, January, February, and March constituted winter. And April, May, and June were spring.

Dietary breadth was calculated by the Shannon-Wiener formula (Shannon and Weaver 1949), while dietary overlap was calculated by the Bray-Curtis index (Bray and Curtis 1957).

RESULTS

MULE DEER

The annual diet of mule deer was predominantly browse (50%), with a large proportion of forbs (39%), and little grass (7%) (Figure 2). This pattern held throughout the year with slight seasonal shifts. Grass use was greatest in November (18%) and March (19%), and was associated with fall and spring "green-up" of several species (Appendix A-1). Forb use was greatest in June (55%), but remained high ($\bar{x}$ = 46%) throughout spring, summer, and fall, and dropped following the first snows in December to a low in winter (26%). Browse use was greatest in December (71%), when snow cover probably reduced the availability of low growing herbaceous species, and forced animals down in elevation to communities in poor ecological condition and which supported lesser quantities of herbaceous species. Shrub use declined gradually through winter and spring to a low in June (38%), after which increased use of bitterbrush (Purshia tridentata) (Figure 3) increased overall browse use during August and September. A second low in shrub use occurred in November (36%).

The high use of bitterbrush in late summer occurred at a time when crude protein for this plant was highest (Bissel and Strong 1955). Reduced use of bitterbrush during the remainder of the year was probably related to its low crude protein levels (Bissel and Strong 1955), and low digestibility (Dietz et. al. 1962, Ward 1971). The most important shrub species for mule deer, especially in spring, was

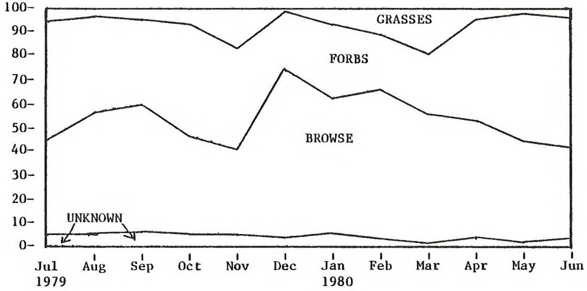

Figure 2. Monthly diets of mule deer by forage class on Sheldon National Wildlife Refuge, July 1979 to June 1980.

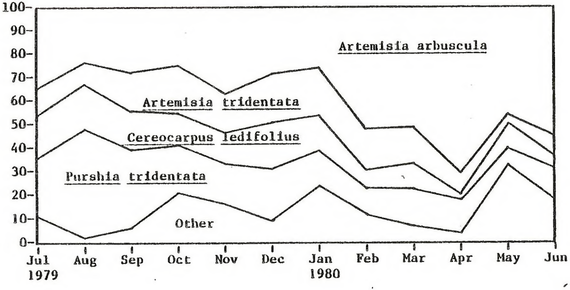

Figure 3. Monthly variation in browse utilization by mule deer on Sheldon National Wildlife Refuge, July 1979 to June 1980.

low sagebrush (Artemisia arbuscula) (20% of the annual diet, 39% of the browse forage class). Big sagebrush (A. tridentata) (15% of all browse) and curlleaf mountain mahogany (13% of all browse) were also major (>5% of annual diet) forage species, particularly during summer, fall, and winter (Table 1). Willow and snowberry (Symphoricarpos spp.) were used during January and May, respectively. In all, 12 genera and at least 10 species of browse appeared in mule deer diets on SNWR.

Two forbs were the only other major use plants for deer, fleabane (Erigeron spp.) (7%) and rockcress (Arabis spp.) (7%). While 36 genera and at least 36 species of forbs appeared in the diets of mule deer, only 10 taxa occurred in more than trace quantities (Appendix A-1). Deer ate 12 genera and at least 11 species of grass and grass-likes, but only 2 occurred in more than trace amounts.

PRONGHORN ANTELOPE

Pronghorn antelope annual diets consisted of nearly equal proportions of forbs (46%) and browse (45%) (Figure 4), with a slight tendency toward more forbs in spring (52%), and more browse in summer (48%) and fall (54%). Grasses, 11% of the winter diet, increased in use through the winter to a high of 20% in March, but were used little (<5%) during the remainder of the year (Appendix A-2).

Three shrubs, low sagebrush, big sagebrush, and bitterbrush, together made up 91% of the browse in the annual diet of pronghorn on SNWR (Figure 5). While these shrubs were each used to some extent throughout the year, only low sagebrush was consistently more than 15%

Table 1. Major plant species (> 5%) found in annual diets of 5 ungulates on Sheldon National Wildlife Refuge, 1979-80.

Species	Mule Deer	Pronghorn Antelope	Bighorn Sheep	Domestic Cattle	Feral Horse
Agropyron spicatum					24
Elymus cincereus				7	
Festuca idahoensis			9	20	
Hordeum jubatum					7
Koeleria nitida			5	6	
Poa sandbergii					6
Stipa thurberiana			7	20	32
Sum			21	53	69
TOTAL GRASSES	7	5	42	86	86
Arabis cobrensis	6	6	6		
Erigeron spp.	7	11	8		
Lupinus lepidus					6
Sum	13	17	14		6
TOTAL FORBS	39	46	40	11	12
Artemisia arbuscula	20	23	7		
Artemisia tridentata	7	6			
Cercocarpus ledifolius	6				
Purshia tridentata	10	11			
Sum	43	40	7		
TOTAL SHRUBS	50	45	14	1	0

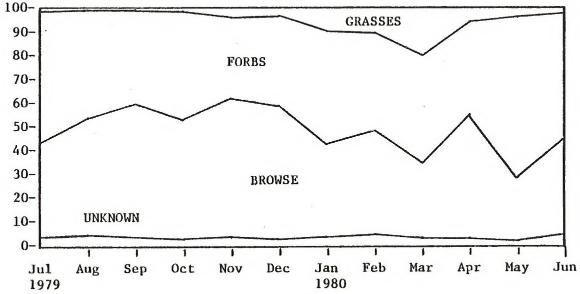

Figure 4. Monthly diets of pronghorn antelope by forage class, on Sheldon National Wildlife Refuge, July 1979 to June 1980.

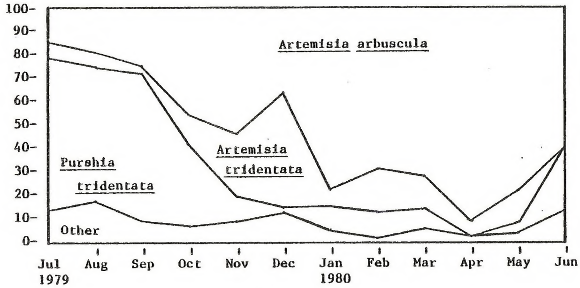

Figure 5. Monthly variation in browse utilization by pronghorn antelope on Sheldon National Wildlife Refuge, July 1979 to June 1980.

of the browse forage class. Low sagebrush was used least in summer (20% of all browse). Like deer, antelope during summer shifted their browse consumption to bitterbrush (61% of all browse) to take advantage of this species when its crude protein levels were highest. Big sagebrush was used most in November and December (27 and 49% of all browse, respectively), when the animals were moving to their winter range and dealing with accumulated snow. Ten genera and at least 9 browse species were found in pronghorn diets.

The only other major use species were the same forbs used by deer, fleabane (11%) and rockcress (6%). Both plants were used consistently through the year, but fleabane use was much higher in spring, especially May (42%). Thirty-six genera and at least 36 species of forbs appeared in the antelope diets. Several grasses, 11 genera and at least 9 species, appeared in antelope diets, particularly in winter. Junegrass (Koeleria nitida) (1%) and Indian ricegrass (Oryzopsis hymenoides) (T) were the primary species.

BIGHORN SHEEP

The diets of bighorn sheep, unlike the other animals, included major use species in all 3 forage classes (Table 1). Sheep ate primarily grasses (42%) and forbs (40%) (Figure 6). However, use shifted markedly between these forage classes on a seasonal basis. When "green-up" began in spring, use shifted heavily to forbs (75%) (Appendix A-3). Forb use gradually declined through summer (49%), to a low in fall (17%) and winter (19%). Grass use was inversely related

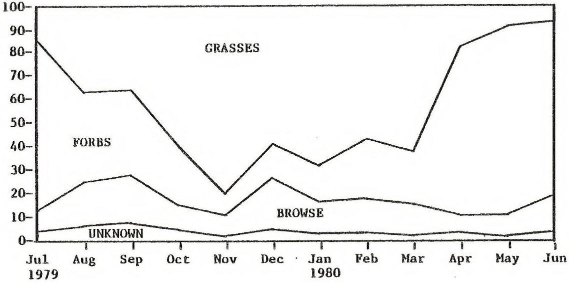

Figure 6. Monthly diets of bighorn sheep by forage class, on Sheldon National Wildlife Refuge, July 1979 to June 1980.

to forb use, and was lowest in spring (12%), increased through summer (30%) to highs in fall (70%) and winter (62%). Browse use was noted throughout the year, with highs in August (19%) and September (20%) which may have been associated with peak crude protein levels in these plants, and in December (22%) which was probably associated with snow covering herbaceous plants. Heavy forb use in spring was probably associated with high protein and energy levels in early phenological stages of these plants. Sheep relied heavily on grasses for winter maintenance.

Three grasses consistuted major use species, Idaho fescue (_Festuca idahoensis_) (9%), Thurber's needlegrass (_Stipa thurberiana_) (7%), and Junegrass (5%). In all, 17 genera and at least 16 species of grasses were found in bighorn diets. Sheep ate a greater variety of forbs than any of the other animals, 45 genera and at least 55 species but like both deer and antelope, fleabane (8%) and rockcress (6%) constituted the only major use forb species. Both were used consistently throughout the year, but fleabane was used most in spring (18%), while rockcress was used most in summer (12%), especially July (22%). Several browse species, 9 genera and at least 9 species, were used throughout the year, but only low sagebrush was a major use species (7%), and it was used most during winter (10%). The diets of bighorn sheep included a greater number of plants than did those of the other 4 ungulates, 70 genera and at least 80 species.

DOMESTIC CATTLE

Cattle primarily ate grasses while on the rangelands, between May and December (86%) (Figure 7). Forb use averaged 11% during this

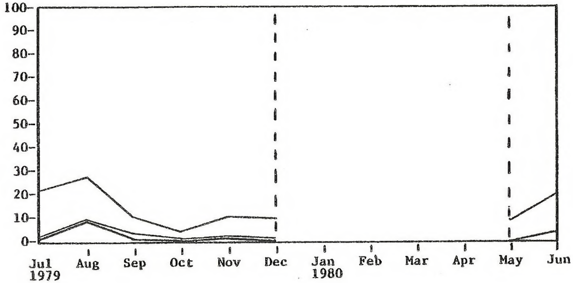

Figure 7. Monthly diets of domestic cattle by forage class, on Sheldon National Wildlife Refuge, July 1979 to June 1980.

period, but increased in late spring-early summer to a high in July of 20% (Appendix A-4). Very little browse (1%) was used by cattle during these months.

Four plants constituted major use species for cattle (Table 1). All 4 were grasses, Thurber's needlegrass (20%), Idaho fescue (20%), Great Basin wildrye, (Elymus cinereus), (7%), and Junegrass (6%). A tendency was noted for cattle to eat fine-leaved grasses, such as the needlegrass and fescue, during all seasons, but especially spring and summer, and to increase intake of coarser grasses, such as the wildrye, Junegrass, and bluebunch wheatgrass (Agropyron spicatum), during fall and winter. In all, cattle used 18 genera and at least 17 species of grasses.

Of the 24 genera and at least 22 species of forbs eaten by cattle, none were considered major use species. The 4 forbs taken in more than trace amounts were all used consistently by the 3 big game species, and 2 of these were fleabane and rockcress. Browse consumed by cattle included 5 genera and at least 4 species.

FERAL HORSE

Grasses made up the bulk (86% annually) of feral horse diets (Figure 8), particularly from November to April ($\overline{x} = 96\%$) (Appendix A-5). During late spring and early summer, forb use increased to a maximum in July (44%). Feral horses used browse sporadically in very small amounts (<3%) throughout the year.

Four of the 5 major use plants for horses were grasses; Thurber's needlegrass (32%), bluebunch wheatgrass (24%), foxtail barley (Hordeum

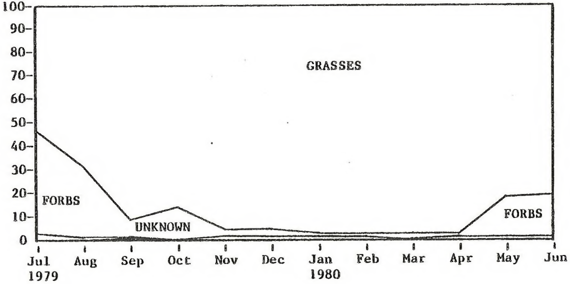

Figure 8. Monthly diets of feral horses by forage class, on Sheldon National Wildlife Refuge, July 1979 to June 1980.

jubatum) (7%), and Sandberg's bluegrass (*Poa sandbergii*) (6%). Thurber's needlegrass and bluebunch wheatgrass were the staples of horse diets, the former particularly so during winter (43%) and the latter in fall (43%). However, feral horses ate a large variety of other grasses, 19 genera and at least 26 species.

The fifth major use plant for feral horses was a forb, prairie lupine (*Lupinus lepidus*) (6%). Prairie lupine was almost exclusively used in the spring and summer, with greatest use in July (20%). In all, horses consumed forbs from 27 genera and at least 30 species, most of which also occurred in the diets of the other 4 ungulates. Six genera and 7 species of shrubs also appeared in horse diets.

DISCUSSION

Several sources of potential bias in the results existed including the previously noted long storage time for some samples, and the addition of 40 forb specimens to the reference set late in the lab analyses. A change of technical personnel at the lab resulted in identification to species level of some taxa which previously had been lumped at the genus level. The problem of comparability of genus and species level taxa was handled by deleting all such taxa from calculations of dietary breadth and overlap. Generally, the apparent breadth or overlap, as displayed in the tables, was reduced by this procedure.

A further bias which should be recognized in interpretation of these data is the differential digestibility of plant species and forage classes. The amount of a plant present in the feces of an herbivore is dependent on the amount eaten, and the amount removed through digestion. Factors affecting the proportion of a plant which is digested include forage succulence and chemical composition, various micro-histological structural characteristics, type of digestion apparatus (ie., ceacal vs. ruminant), rumen volume, and rate of passage through the gut. Although most of these factors have been addressed in several studies, the number of variables generally precludes use of correction factors to adjust specific data sets. However, the general effects of these factors should be considered in interpreting these data.

As a result of differential digestibility, most forbs are under-represented in fecal analysis data, although great variability exists between species. Similarly, green forage of all types is usually digested more completely than dry forage. Some plants contain structures or chemical compounds, such as thick, lignified cell walls or monoterpenoids, which may inhibit their digestion (Welch and Pederson 1981), thus increasing their relative presence in the feces. Type of digestion apparatus and rumen volume are constants for each animal species, but may affect between species comparisons. Rate of passage through the gut may vary seasonally, and is dependent on both plant succulence and animal physiology.

DIETARY BREADTH

Dietary breadth is a measure of the variety of foods in an animal's diet. As calculated here ($B_i' = -\sum_j p_{ij} \log p_{ij}$, where p_{ij} is the proportion of food item "j"in the diet of animal "i") (Shannon and Weaver 1949), it is affected by both the number of plant species eaten and the amount of each eaten. It reached its maximum value of 2.0 when all 100 plant species identified in the diets of these 5 animals were eaten in equal amounts. A minimum of 0.0 resulted when an animal's diet consisted of only 1 plant species. Monthly values in this study ranged from 0.5 for horses in November to 1.4 for bighorn in May (Appendix B).

Only those plant taxa which were identified to the species level were used in these calculations. The inclusion of taxa at the genus level would have increased each calculated annual value by approximately 0.1. On an annual basis, bighorn sheep diets exhibited the greatest breadth (1.5), followed by mule deer (1.3), pronghorn antelope (1.2), domestic cattle (1.1), and feral horses (1.0). A ranking of these animals by number of genera included in the diet was similar to the ranking by breadth, with the exception that feral horses ate plants from 5 more genera than did domestic cattle, thereby ranking fourth. However, horses ate only a few plants in any quantity.

It was apparent that the 3 wildlife species selected their forage from a much broader range of the available forage plants than did the 2 exotic species. The selection of a broad range of plants as forage by the 3 wildlife species reflected a heavy use of the forb forage class, which contained the greatest variety of species, but was usually found in the lowest quantities (Table 2). Heavy use of forbs by the 3 wildlife species probably reflected their need for forage

Table 2. Vegetative characteristics of major vegetation types found in the Hell Creek area of Sheldon National Wildlife Refuge (Hansen 1982).

Vegetative Characteristics	Vegetation Types Arid Rolling Hills (611)	Steep South Exposure (641)	South Exposure (642)	Arid North Exposure (652)	North Exposure (653)	Gravelly Ridgetop (623)	Stony Terrace (621)	Claypan Terrace (691)
Dominant Species	*Artemisia tridentata wyomingensis* *Stipa thurberiana*	*Artemisia tridentata tridentata* *Agropyron spicatum*	*Artemisia tridentata wyomingensis* *Poa sandbergii*	*Artemisia tridentata wyomingensis* *Festuca idahoensis*	*Artemisia tridentata vaseyana* *Festuca idahoensis*	*Artemisia arbuscula* *Festuca idahoensis*	*Artemisia arbuscula* *Poa sandbergii*	*Artemisia arbuscula* *Poa sandbergii*
Ecological Cond.	18%	36%	28%	19%	18%	35%	46%	55%
Shrub								
Height (cm)	51.8	62.2	35.7	38.7	42.7	15.1	17.0	15.2
Density (#/m^2)	1.1	0.7	1.3	1.7	1.8	3.2	2.7	5.3
% Cover (Line intercept)	19.3	14.8	15.8	18.5	17.7	10.5	13.6	18.6
% Cover (Plot Frame)								
Shrub	15.4	13.8	14.7	12.0	10.4	10.9	12.0	17.9
Grass	3.9	7.3	6.3	6.3	8.4	5.0	5.8	8.4
Forb	3.0	1.9	5.6	4.6	5.4	3.7	7.1	15.4[a]
Moss	0.7	0.0	0.1	0.5	2.6	0.7	0.2	0.0
Total Vegetation	23.0	23.0	26.7	23.4	26.8	20.3	25.1	41.7
Litter	12.8	9.4	11.5	15.0	16.3	9.5	7.5	10.9
Rock	11.3	39.9	34.5	20.8	9.6	11.7	42.5	12.5
Bare Ground	52.9	27.8	27.4	40.9	47.2	58.4	25.1	34.7

[a] Greater value for Forbs than any other type (t-test, $p < 0.05$).

with relatively higher nutritive quality, due to smaller body size (Jarman and Sinclair 1979:134), than that required by the cattle and horses.

DIETARY OVERLAP

Dietary overlap, or similarity, measures the amount of the diets of 2 animals which consist of the same foods. The formula used here ($S = \Sigma\ 2W/\Sigma\ A_i+B_i$, where A is the proportion of food item "i" in the diet of the first animal, and B is the proportion of food item "i" in the diet of the second animal, and W is the difference between A and B, Bray and Curtis 1957) was used to calculate similarity of the entire diets of a particular pair of animals. Overlap was 100 when 2 animal's diets consisted of exactly the same proportions of the same plant species, and 0 when the 2 animals ate none of the same plants. Monthly values of this index ranged from 1 for deer and horses in December to 72 for bighorn and cattle in November (Appendix C).

As with dietary breadth these calculations included only those taxa which were identified to species. The inclusion of genera would have required the assumption that all animals consumed the same proportions of species within each genus, which, while likely in many cases, could not be verified by the lab. The only genera which would have substantially changed (difference > 5) the resulting values by their inclusion, were the fleabanes and the wheatgrasses (Agropyron spp.). Inclusion of the fleabanes would have increased the overlap values of sheep diets with those of antelope and deer on a monthly basis during the spring months. Inclusion of the wheatgrasses would have slightly decreased the overlap values of horse diets with those of cattle and bighorn during the fall and late summer. Overlap of diets calculated on an annual basis (Table 2) was generally greater than the mean of all monthly overlaps, and reflected the common use of some plants by 2 animals during different months.

Of all possible ungulate pairs, the diets of mule deer and antelope displayed the greatest overlap (Table 3). These 2 animals both relied heavily on forbs and browse and chose similar amounts of several major use species (Table 1), as well as many of the other plants in their diets. Nearly half of the annual diet overlap for deer and antelope came from 3 shrub species, low sagebrush, bitterbrush, and big sagebrush. Because of the high degree of similarity between deer and antelope diets, the overlap exhibited by both species when compared to the other 3 ungulates was also quite similar. Deer and antelope diets each overlapped with the diet of bighorn sheep by nearly 50%. Most of the plants common to the diets of these 3 animals were forbs, but some shrubs, especially low sagebrush, were also used in common. Deer and antelope diets exhibited low overlap with those of feral horses (11 and 10%, respectively), and only slightly greater overlap with the diets of cattle (16 and 12%, respectively). Several forb species contributed to the majority of the overlap in these 4 cases.

The diets of bighorn sheep substantially overlapped with all of the other 4 ungulates (Table 3). This was largely due to the great breadth shown by bighorn diets. As with deer and antelope, bighorn

Table 3. Percent overlap of annual diets for 5 ungulates on Sheldon National Wildlife Refuge, 1979-1980.

	Feral Horse	Domestic Cattle	Bighorn Sheep	Pronghorn Antelope
Mule Deer	11	16	49	76
Pronghorn Antelope	10	12	47	
Bighorn Sheep	28	52		
Domestic Cattle	43			

sheep diets overlapped those of domestic cattle by half (52%). Most of the overlap between the diets of bighorn and cattle was in the grass forage class, although several forbs also contributed to some degree. Bighorn diets overlapped 28% with those of feral horses, largely in the grass forage class. While both cattle and horses ate a large proportion of grasses (86% and 85%, respectively), several of the species were different. The resulting annual dietary overlap was 43%, and the species responsible for nearly half of this overlap was Thurber's needlegrass (20%).

POTENTIAL FOR INTERSPECIFIC COMPETITION

The amount of overlap found between mule deer and antelope indicated a large potential for competition; however, these 2 animals generally used different plant communities, thus avoiding much of the potential. Additionally, a large portion of the diets of each consisted of very abundant shrubs, a forage source which was unlikely to be limiting to either. Competition by sheep and either deer or antelope for shrub and grass forage classes is unlikely due to the high availability of shrubs, and the low use of grasses by deer and antelope. However, bighorn sheep ate similar amounts of most forbs which deer and antelope consumed. Because sheep used primarily the fringes of areas used by both deer and antalope, it is unlikely heavy sheep use would affect the overall forage resource of either; but, heavy use by either deer or antelope might effect the forage resource of the sheep.

Little potential for competition was found for cattle and horses with either deer or antelope in the grass or browse forage classes, since cattle and horses ate virtually no browse and deer and antelope ate very little grass. Only during fall and spring "green-up" did grass use by deer and antelope become significant. However, while only a small proportion of either the cattle or horse diets consisted of forbs (11 and 12%, respectively), due to the large quantity of forage in their diets (5 and 7.5 times, respectively, that of each wildlife species), the quantity of forbs removed by a cow or horse was equal to or greater than that removed by a deer, antelope, or sheep. Cattle consumed many of the same forbs which the wildlife species selected. Half of the forbs eaten by horses were prairie lupine plants which were little used by the wildlife species. However, horses were on the open range year-round, while cattle were removed from the rangelands between November and April. Thus, the quantity of forbs important to the wildlife species which were removed by each cow and horse were probably similar. The distribution of use by cattle and horses was somewhat different though. While both used areas near water extensively, horses tended to also use areas with rougher terrain, or which were more distant from water sources.

The effect of cattle and horse grazing on the forbs which bighorn sheep selected was very similar to their effect on the forb portions of deer and antelope diets. However, since bighorn diets consisted of a large proportion of grasses as well (42%), the grazing of cattle and horses in sheep areas would affect the availability of both major bighorn forage classes, 82% of their diet. While cattle primarily used the fringes of bighorn ranges, they consumed largely the same species of grasses; and while horses generally consumed the coarser grass species, they moved further into sheep areas. Thus, a serious potential existed for competition between bighorn sheep and both cattle and feral horses.

The potential for competition between cattle and horses was great due to their similar preference for grass and forb forage classes; however, the tendency for horses to forage farther from water and to take several species which cattle did not use heavily reduced this potential. It is possible that horses used forage away from water sources as a result of competition with cattle for forage near water.

CONCLUSIONS AND RECOMMENDATIONS

Mule deer, pronghorn antelope and bighorn sheep selected large quantities of forbs, the forage class which was generally least available. Due both to large forage intake per animal and the large number of animals on the range, domestic cattle and feral horses also took large quantities of forbs, even though the proportion relative to their whole diet was low. Forbs probably provide an important protein source to all 5 ungulates, especially in spring when reproductive activities produce high protein demands.

Grasses were important to cattle and horses year-round, supplied energy for winter maintenance for sheep, and supplied both energy and protein for deer and antelope during fall and spring green-up. Little grass was available in most lower elevation areas and in well watered areas frequented by cattle. Shrubs, which were important to deer, to antelope, and to a lesser extent sheep, were abundant throughout the area. Recommendations for vegetation management on SNWR include:

1.- A vegetation manipulation program should be developed for widespread use on SNWR to produce an increase in both native grasses and forbs. This program should employ regular prescribed burning and/or mechanical treatments to reduce, but not eliminate, shrubs. Where an adequate herbaceous understory is absent, seeding of a mixture of native grasses and forbs may be necessary.

2.- Grazing by cattle and horses should be reduced, to promote the return of forb and grass forage classes particularly in bighorn areas and those areas used by deer and antelope for fawning and wintering.

3.- Riparian and meadow sites are areas of high forb and grass production and are important to all animals on rangelands. Thus, particular attention should be given to riparian and adjacent areas to arrest stream channel erosion and control over grazing in cattle concentration areas.

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Appendix A-1. Relative density of plant species in fecal samples from mule deer on Sheldon National Wildlife Refuge, Nevada, 1979 and 1980.

	1979						1980											
Species	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Summer	Fall	Winter	Spring	% of Forage Class	% of Annual Diet
GRASSES																		
Agropyron spp.								2	4						1		6	T
Agrostis exarata	T		T						T				T		T		3	T
Bromus spp.	1	T	1		2	T					T		T	1	T	T	6	T
Carex douglasii	2	1	2	2	5		T	T		T	1	1	1	4	T	1	19	1
Elymus cinereus									T						T		T	T
Festuca idahoensis					2	T	2		3	1	T			1	1	T	12	T
Juncus balticus	1	1		1	2							1	T	2		T	9	T
Koeleria nitida								2	3						1		5	T
Oryzopsis hymenoides				T	1		2	5	5					T	3		16	1
Phalaris arundinacea			T										T				T	T
Poa nevadensis										T		1				T	2	T
Poa sandbergii								T							T		T	T
Poa spp.			1	1			T						T	T	T		3	T
Stipa thurberiana			T		2		2	1	T	T			T	1	1	T	8	T
Stipa spp.										T						T	T	T
Unknown Grasses	T	—	—	2	2	T	1	—	2	—	—	—	T	2	T	—	10	T
Total Grasses	5	3	5	7	17	1	7	11	19	3	2	3	5	12	9	3	100	7
FORBS																		
Arabis cobrensis	8	8	6	9	5	3	2	2	5	3	5	11	7	7	3	6	14	6
Arabis puberula										6	9	3				6	4	2
Artemisia ludoviciana	4	5	3	4	3	2		2	2	T		3	4	4	2	1	6	2
Aster occidentalis	1	1			1		1			1	T		T	T	T	T	1	T
Astragalus curvicarpus								T		T	2	T			T	1	1	T
Astragalus purshii	2	2	1					2	5	T	6		2		2	2	4	2
Astragalus spp.						T									T		T	T
Balsamorhiza hookeri	1		1	2	3	T	2	2	1	2	2	4	T	3	2	3	5	2
Camissonia tanacetifolia	1		1	T	2	T			T			T	T	1	T	T	1	T
Castilleja chromosa	2	2	3						T	2		T	2		T	T	2	T
Chaenactis douglasii			1							T	4		T			2	1	T
Circium vulgare						1		T							T		T	T
Cryptantha circumscissa	1		2										1				T	T
Cryptantha humilis			2		3	1		T	2	T	T	3	T	1	1	2	3	1
Descurainia pinnata										8	2					3	2	T
Eriastrum wilcoxii		3	2	T	T								2	T			1	T
Erigeron spp.	4	3	2	6	11	6	7	4	4	14	11	12	3	8	5	12	18	7
Eriogonum caespitosum		1	T										T				T	T
Eriogonum ovalifolium	3	1		3		2	4	4	1	2	4	3	1	2	2	3	5	2
Eriogonum umbellatum										T						T	T	T
Erodium cicutarium												T				T	T	T
Euphorbia spp.		T											T				T	T

Appendix A-1. Continued

Species	1979 July	Aug	Sep	Oct	Nov	Dec	1980 Jan	Feb	Mar	Apr	May	June	Summer	Fall	Winter	Spring	% of Forage Class	% of Annual Diet
Galium multiflorum	2			1	2	2	3						T	2	1		2	T
Galium spp.			2										T				T	T
Haplopappus scaulis	3	2	2	6	2		1				1	4	3	4	T	2	5	2
Lesquerella kingii												T				T	T	T
Lithospermum ruderale	1	1	1	1			1						1	T	T		1	T
Lupinus spp.		T											T				T	T
Mentha arvensis				2			1							T	T		T	T
Mentzelia spp.	T	T	1										T				T	T
Nicotiana spp.						1	2									T	T	T
Oenothera spp.				2										T			T	T
Penstemon humilis				1										T			T	T
Penstemon speciosus	2			1	1							2	T	1		T	1	T
Penstemon spp.		1	1			T							T		T		T	T
Phlox hoodii	2	1	T	2	1		1				T	1	1	2	T	T	2	T
Phlox spp.		2	1										1				T	T
Phoenicaulis cheiranthoides				1	2				T	2	2	5		2	T	3	3	1
Potentilla rivularis	4				1		1	2			1		1	T	T	T	2	T
Ranunculus cymbalaria										T						T	T	T
Rumex crispus	2												T				T	T
Senecio canus	3	2	2	3	2	3	4	2	3	1	1	1	2	3	3	1	6	2
Senecio spp.		2											T				T	T
Silene scaposa								3	1						1		T	T
Smilacina stellata					T									T			T	T
Solidago spectabilis	1												T				T	T
Trifolium wormskjoldii				T										T			T	T
Total Forbs	50	41	36	46	42	24	31	23	25	44	53	55	42	44	26	50	100	39
SHRUBS																		
Amelanchier utahensis			T	1									T	T			T	T
Artemisia arbuscula	14	12	15	10	13	20	15	33	28	35	20	21	13	12	24	25	39	20
Artemisia tridentata	5	5	8	9	6	15	11	11	9	4	2	3	6	7	11	3	15	7
Cercocarpus ledifolius	7	10	8	5	5	14	8	5	5	1	4	2	8	5	8	2	13	6
Chamaebatiaria millifolium										T						T	T	T
Grayia spinosa			1	2	6	T	2	1		T		T	T	4	1	T	2	1
Holodiscus dumosus	4		1	3		T					3	3	2	2	T	2	2	1
Prunus virginiana	T	1	1										1				T	T
Purshia tridentata	10	23	17	9	6	16	8	7	8	7	3	5	17	7	10	5	20	10
Ribes spp.				1							2			T		T	T	T
Salix spp.						5	11	6	4						7		4	2
Symphoricarpos spp.										1	9	4				5	2	1
Tetradymia canescens				2										T			T	T
Total Shrubs	40	51	53	42	36	71	56	63	54	50	43	38	48	39	61	44	100	50
Unknown Shrub or Forb	5	5	6	5	5	4	6	3	2	3	2	4	5	5	4	3		4

Appendix A-2. Relative density of plant species in fecal samples from pronghorn antelope on Sheldon National Wildlife Refuge, Nevada, 1979 and 1980.

	1979						1980										% of Forage Class	% of Annual Diet
Species	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Summer	Fall	Winter	Spring		
GRASSES																		
Agropyron spp.		T					1	2	2	2	T		T		1	T	11	T
Agrostis exarata									T	1		T			T	T	4	T
Bromus spp.										T		T				T	2	T
Carex douglasii							2								T		3	T
Carex spp.					T	1		2						T	T		7	T
Festuca idahoensis	1	T	T	T	T	1			T	1	T		T	T	T	T	10	T
Juncus balticus									T						T		T	T
Koeleria nitida							3	3	5						3		19	1
Oryzopsis hymenoides							3	2	5			T			2	T	16	T
Poa nevadensis				T			T	T			2			T	T	T	5	T
Poa spp.						T				T		T			T	T	2	T
Sitanion hystrix					T									T			T	T
Stipa thurberiana						T			4	T					1	T	9	T
Stipa spp.				T	1						T			T		T	3	T
Unknown Grasses	T			T	T			T	2		T	T	T	T	T	T	8	T
Total Grasses	1	T	T	1	3	3	10	10	20	6	3	2	1	2	11	4	100	5
FORBS																		
Achillea lanulosa	6	3	T		2		T				2	T	3	T	T	T	2	1
Arabis cobrensis	3	7	7	9	6	4	2	4	5	7	5	12	6	8	4	8	13	6
Artemisia ludoviciana						T	6	5	5						4		3	1
Aster eatonii							T								T		T	T
Aster occidentalis	2	4		1			2		2	T		3	2	T	1	1	3	1
Aster scopulorum	T				T							6	T	T		2	1	T
Aster spp.		T	T	T	2						T		T	1		T	T	T
Astragalus curvicarpus	2	T	2							1	3	3	2			2	2	1
Astragalus purshii					T									T			T	T
Astragalus spp.				T			2	T						T	T		T	T
Balsamorhiza hookeri	3			1	T		4	4	4			1	1	T	3	T	3	2
Balsamorhiza sagittata								1							T		T	T
Balsamorhiza serrata		T	2	3		2							T	2	T		1	T
Balsamorhiza spp.					2	T								T	T		T	T
Camissonia tanacetifolia			T	T		T	1	T	T				T	T	T		T	T
Castilleja chromosa	2	T		T	T				1	2	T	2	T	T	T	2	2	T
Castilleja spp.	2			1		T						1	T	T	T	T	1	T
Chaenactis douglasii							4								T		T	T
Cirsium vulgare	T				T								T	T			T	T

Appendix A-2. Continued

	1979						1980										% of	% of
Species	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Summer	Fall	Winter	Spring	Forage Class	Annual Diet
Cryptantha humilis						2	3	1	2						2		2	T
Cryptantha spp.				T										T			T	T
Eriastrum wilcoxii											T					T	T	T
Erigeron spp.	6	4	10	7	4	3	9	4	7	20	42	18	7	6	6	27	24	11
Eriogonum caespitosum		3					2	5	4	2			T		3	T	3	1
Eriogonum ovalifolium			1	1			1	2	2			T	T	T	1	T	2	T
Eriogonum spp.	6	1	2	2	4	4				T	4	1	3	3	1	2	5	2
Erodium cicutarium						2									T		T	T
Galium multiflorum					T		3	1	3					T	2		1	T
Gilia spp.	T												T				T	T
Haplopappus acaulis			4	4	2	3		T	2		3	1	1	3	1	1	4	2
Lepidium spp.		T	2	T	T	T					T		T	T	T	T	T	T
Leptodactylon pungens			T										T				T	T
Lesquerella kingii				4	6	8					T			5	2	T	3	2
Lithospermum ruderale	1	T				T				T	1		T		T	T	T	T
Lupinus lepidus								T							T		T	T
Marrubium vulgare						T									T		T	T
Mentha arvensis			T					T					T		T		T	T
Penstemon spp.	5	3		1	2	T					T	T	3	2	T	T	2	1
Phacelia linearis											2					T	T	T
Phacelia spp.					T									T			T	T
Phlox hoodii	8	8	3	3		1					1	T	6	2	T	T	5	2
Phlox spp.			1										T				T	T
Phoenicaulis cheiranthoides	3	1	1	T						3	T		2	T		1	2	T
Polygonum spp.								T	T						T		T	T
Potentilla rivularis	4	8		2							1	T	4	T		T	3	1
Rumex spp.					T	T				2				T	T	T	T	T
Senecio canus						T	7	9	6						6		4	2
Senecio spp.			T	2		T							T	T	T		T	T
Smilacina stellata							1								T		T	T
Solidago spectabilis								T							T		T	T
Zigadenus venenosus								T							T		T	T
Total Forbs	55	45	40	46	35	37	47	40	45	38	68	52	47	40	42	52	100	46
SHRUBS																		
Artemisia arbuscula	6	10	14	23	34	21	30	30	22	47	21	24	10	27	26	31	51	23
Artemisia tridentata	3	3	2	6	16	28	3	8	4	3	4		2	11	11	2	14	6
Cercocarpus ledifolius							T		1						T		T	T
Chamaebatiaria millifolium								1		1		T			T	T	T	T
Chrysothamnus nauseosus							T								T		T	T
Chrysothamnus viscidiflorus	3	T			4	5				2	1	2	1	2	1	1	3	1

Appendix A-2. Continued

Species	1979 July	Aug	Sep	Oct	Nov	Dec	1980 Jan	Feb	Mar	Apr	May	June	Summer	Fall	Winter	Spring	% of Forage Class	% of Annual Diet
Grayia spinosa	2	5	1	1	1		T	1	T			3	3	1	T	1	3	2
Holodiscus dumosus	T	1	1	2		2						T	1	T	T	T	2	T
Purshia tridentata	26	28	35	17	6	1	4	5	2		1	11	30	12	3	4	25	11
Salix spp.		T	T										T				T	T
Symphoricarpos spp.		1	2	T									1	T			T	T
Tetradymia spp.						T									T		T	T
Total Shrubs	40	50	56	50	58	57	38	45	31	53	27	41	48	54	43	40	100	45
Unknown Shrub or Forb	4	5	4	3	4	3	5	5	4	3	2	5	4	4	4	4		4

Appendix A-3. Relative density of plant species in fecal samples from bighorn sheep on Sheldon National Wildlife Refuge, Nevada, 1979 and 1980.

Species	1979 July	1979 Aug	1979 Sep	1979 Oct	1979 Nov	1979 Dec	1980 Jan	1980 Feb	1980 Mar	1980 Apr	1980 May	1980 June	Summer	Fall	Winter	Spring	% of Forage Class	% of Annual Diet
GRASSES																		
Agropyron spp.	T		T	3	4	5	3	5	5	1	2		T	4	4	T	6	2
Agrostis exarata		T		2	1	T	1	3	1				T	2	2		2	T
Bromus spp.		1	3	2	2	2	2	3	2	2	T		1	2	2	T	4	2
Carex douglasii	T	1		1	3	T	2	2	1		1		T	2	2	T	2	1
Carex spp.										3						1	T	T
Elymus cinereus	1	2	3	4	2	3	3	2	3	T	T		2	3	3	T	5	2
Elymus triticoides								T							T		T	T
Eragrostis spp.										T						T	T	T
Festuca idahoensis	4	15	10	20	12	11	15	10	7		2	2	10	16	11	1	21	9
Hordeum brachyantherum		2	3	2	3	10	7	5	2	3		T	2	2	6	1	7	3
Juncus balticus		T		T	1		1	T	1				T	T	T		1	T
Juncus drummondii						2									T		T	T
Koeleria nitida	T	2	1	8	15	7	9	5	10	T	T	T	1	11	8	T	12	5
Muhlenbergia spp.		T	2	T		T		T					T	T	T		T	T
Oryzopsis hymenoides	2	2	2	4	6	4	6	4	12				2	5	6		8	3
Panicum capillare						T									T		T	T
Phalaris arundinacea		1		T	T		1						T	T	T		T	T
Poa nevadensis		2	2	2	T	1	T	2	1	T	T	1	1	2	1	T	3	1
Poa sandbergii			2	4	1	1	1		1				T	2	T		2	T
Sitanion hystrix	T	1			3	2	3	2	1	2	T		T	2	2	T	3	1
Stipa thurberiana	5	6	5	4	22	7	11	11	12	3	T	2	5	13	10	2	18	7
Stipa spp.							1	T							T		T	T
Unknown Grasses	T	T	1	2	2	2	2	3	3	2	T	2	T	2	3	2	4	2
Total Grasses	15	37	36	59	80	59	68	57	62	18	9	7	29	70	62	11	100	42
FORBS																		
Achillea lanulosa	T												T				T	T
Amsinckia tessellata										T	T	T				T	T	T
Arabis cobrensis	22	10	4	4	2	2	4	6	4	3		6	12	3	4	3	14	6
Arabis puberula											3					1	T	T
Artemisia ludoviciana	T	1	2	2	T	T	T	2	1	2	3	2	1	1	1	2	4	2
Aster occidentalis	2	T	3	2					1	2	2	2	2	T	T	2	3	1
Aster scopulorum	T												T				T	T
Astragalus curvicarpus		T	T	T		T		T			11	3	T	T	T	5	3	1
Astragalus malacus										T						T	T	T
Astragalus obscurus											T					T	T	T
Astragalus purshii	4	2	T					3	1		4	8	2		1	4	5	2
Balsamorhiza hookeri	9	4	3	T	2	3	2	T		T	2	3	5	T	2	2	6	2
Balsamorhiza serrata										2	2	2				2	1	T
Camissonia tanacetifolia	1	T		T		T	T	T		T	2		T	T	T	T	1	T

Appendix A-3. Continued

Species	1979 July	Aug	Sep	Oct	Nov	Dec	1980 Jan	Feb	Mar	Apr	May	June	Summer	Fall	Winter	Spring	% of Forage Class	% of Annual Diet
Castilleja chromosa	T	2											T				T	T
Chaenactis douglasii										T						T	T	T
Cirsium vulgare			T										T				T	T
Crepis modocensis										T						T	T	T
Cryptantha humilis	T	T	2	2	1	1	T	3	2		5	4	1	2	2	3	5	2
Descurainia pinnata										1	3	5				3	2	T
Draba douglasii											T					T	T	T
Eriastrum wilcoxii		T	T										T				T	T
Erigeron spp.	14	5	7	4	2		4	6	4	19	21	13	9	3	3	18	21	8
Eriogonum caespitosum	2								T	5	3	3	T		T	4	3	1
Eriogonum ovalifolium						T				11	2	6				6	4	2
Eriogonum umbellatum		1								3			T		T	1	T	T
Erodium cicutarium									T						T		T	T
Eupatorium occidentale								T							T		T	T
Galium multiflorum	4	T	1	1	1	1	T	1		T	T	1	2	1	T	T	3	1
Geum macrophyllum											T					T	T	T
Haplopappus acaulis	T		2	T		T	T						T	T	T		T	T
Haplopoppus stenophyllus									T						T		T	T
Lappula redowskii										1		2				T	T	T
Lesquerella kingii									2						T		T	T
Lithospermum ruderale	T								T	2	1		T		T	1	1	T
Lupinus argenteus				1										T			T	T
Lupinus lepidus										1	T					T	T	T
Machaeranthera canescens	T											T	T			T	T	T
Mentha orvensis		T											T				T	T
Mertensia oblongifolia												T				T	T	T
Microsteris gracilis											T					T	T	T
Penstemon humilis			2									2	T			T	T	T
Penstemon speciosus											1	T				T	T	T
Penstemon spp.	T		2	1		T	T						T	T	T		T	T
Phacelia linearis										4	3	1				3	2	T
Phlox hoodii			2	2									T	T			T	T
Phoenicaulis cheiranthoidea	6	4	2	2	T		T		T		5	T	4	1	T	2	4	2
Plectritus macrocera											T	2				T	T	T
Potentilla rivularis		T	T								T		T			T	T	T
Ranunculus cymbalaria												T				T	T	T
Rumex triangulivalvis		1											T				T	T
Senecio canus	3		3	4	T	3	1	1	4	1	1	3	2	2	2	2	5	2
Silene scaposa					T									T			T	T
Smilacina stellata	T										T	T	T			T	T	T
Solidago spectabilis		T	T										T				T	T
Trifolium wormskjoldii	T	T											T				T	T
Viola nuttallii										T	T	T				T	T	T
Unknown Forbs	—	—	—	—	—	—	—	—	—	6	2	3	—	—	—	4	2	T
Total Forbs	72	37	36	26	9	14	15	25	22	71	80	74	49	17	19	75	100	40

Appendix A-3. Continued

Species	1979						1980										% of Forage Class	% of Annual Diet
	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Summer	Fall	Winter	Spring		
SHRUBS																		
Artemisia arbuscula	5	6	6	4	7	13	9	11	8	6	3	4	6	5	10	4	49	7
Artemisia tridentata	1	2	6	4	1	4	4	3	4			T	3	3	4	T	18	2
Cercocarpus ledifolius					T						T			T		T	T	T
Chamaebatiaria millifolium								T			T				T	T	T	T
Grayia spinosa	T	8	3	1	T	2	1	T	1	1	2	1	4	1	1	1	13	2
Holodiscus dumosus			T			T						2	T		T	T	2	T
Purshia tridentata	1	3	5			3		T	1	T	3	6	3		1	3	14	2
Ribes cereum				T										T			T	T
Ribes spp.											T					T	T	T
Symphoricarpos spp.											T	2				T	1	T
Tetradymia spp.	T												T				T	T
Total Shrubs	9	19	20	10	9	22	14	15	14	7	9	15	16	10	16	11	100	14
Unknown Shrub or Forb	4	7	8	5	2	5	3	3	2	4	2	4	6	3	3	3		4

Appendix A-4. Relative density of plant species in fecal samples from domestic cattle on Sheldon National Wildlife Refuge, Nevada, 1979 and 1980.

Species	1979 July	Aug	Sep	Oct	Nov	Dec	1980 Jan	Feb	Mar	Apr	May	June	Summer	Fall	Winter	Spring	% of Forage Class	% of Annual Diet
GRASSES																		
Agropyron spp.	T			2	4	6					2	3	T	3	6	3	3	2
Agrostis exarata		8	2		2								3	1			2	2
Alopecurus aequalis			T										T				T	T
Bromus spp.	T	2	1	1								T	1	T		T	T	T
Carex douglasii	8	3	1	7	3	3					11	11	4	5	3	11	7	6
Eleocharis palustris		T											T				T	T
Elymus cinereus	3	13	4	6	6	11		NO			10	4	7	6	11	7	8	7
Elymus triticoides					T							T		T		T	T	T
Festuca idahoensis	18	12	40	17	19	20					15	18	23	18	20	16	23	20
Hordeum brachyantherum	1			11	7	7					2	1	T	9	7	1	4	4
Juncus balticus	5	T	T	5	2	T					3	2	2	4	T	3	3	2
Koeleria nitida	4	3	7	10	10	10		DATA			3	2	5	10	10	3	7	6
Muhlenbergia spp.		T			T	2						T	T	T	2	T	T	T
Oryzopsis hymenoides	3	2	2	3	3	3					8	6	2	3	3	7	4	4
Phalaris arundinacea	3	2	T	5	2	T					6	3	2	4	T	4	3	3
Poa nevadensis	2	1	T			2							1		2		T	T
Poa sandbergii	2	2		1	2								1	1			T	T
Poa spp.		2											T				T	T
Scirpus microcarpus			T										T				T	T
Sitanion hystrix	3	T		4	4	5					5	5	1	4	5	5	4	3
Stipa thurberiana	19	19	27	20	18	16					21	20	22	19	16	21	24	20
Stipa spp.			T										T				T	T
Unknown grasses	5	1	2	3	5	3	—	—	—	—	3	2	3	4	3	3	4	3
Total Grasses	77	72	89	95	89	90					91	80	80	92	90	85	100	86
FORBS																		
Arabis cobrensis	2	1	T	1	1						2	3	1	1		2	12	1
Artemisia ludoviciana		T			1								T	T			2	T
Aster occidentalis	4	3	T		1	2							2	T	2		12	1
Aster spp.											2	2				2	4	T
Astragalus purshii	5	3									2	4	3			3	16	2
Balsamorhiza hookeri					2	2								T	2		4	T
Cryptantha humilis	1					T		NO			T	T	T		T	T	4	T
Eriastrum wilcoxii		T											T				T	T
Erigeron spp.	3	T	T	1	2	2					2	3	1	1	2	2	14	2
Eriogonum caespitosum		1	T										T				2	T
Galium multiflorum	2	1						DATA			T	1	1			T	6	T
Halogeton glomeratus			T										T				T	T
Haplopappus acaulis						T						T			T	T	2	T
Lesquerella kingii												T				T	T	T

Appendix A-4. Continued

Species	1979 July	Aug	Sep	Oct	Nov	Dec	1980 Jan	Feb	Mar	Apr	May	June	Summer	Fall	Winter	Spring	% of Forage Class	% of Annual Diet
Lupinus lepidus	T												T				T	T
Machaeranthera canescens	T												T				T	T
Mentha arvensis		T											T				T	T
Mentzelia spp.		T	1						N O				T				2	T
Oenothera spp.		T										T	T			T	1	T
Penstemon humilis			T										T				T	T
Penstemon speciosus			T										T				T	T
Penstemon spp.		T							D A T A			T	T			T	2	T
Phlox hoodii		2	T			T							T		T		3	T
Phlox spp.		T											T				T	T
Phoenicaulis chieranthoides			T										T				T	T
Potentilla rivularis	T		T										T				1	T
Senecio canus		2	2	1	T								1	1			7	T
Smilacina stellata	T												T				T	T
Total Forbs	20	17	6	3	8	8					9	16	14	6	8	13	100	11
SHRUBS																		
Artemisia arbuscula				T					N O					T			7	T
Cercocarpus ledifolius		1	T										T				12	T
Grayia spinosa					1	T						4		T	T	2	45	T
Holodiscus dumosus		T	T						D A T A				T				23	T
Ribes cereum		T	T										T				9	T
Salix spp.	T												T				4	T
Total Shrubs	1	2	3	1	1	T					0	4	2	1	T	2	100	1
Unknown Shrubs or Forbs	2	9	2	1	2	2					0	0	4	1	2	0		2

Appendix A-5. Relative density of plant species in fecal samples from feral horses on Sheldon National Wildlife Refuge, Nevada, 1979 and 1980.

	1979						1980										% of	% of
Species	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Summer	Fall	Winter	Spring	Forage Class	Annual Diet
GRASSES																		
Agropyron spicatum	8	4	18	39	46	42	19	30	13	27	22	21	10	43	26	23	28	24
Agropyron trachycaulum	2	2											1				T	T
Agrostis stolonifera	1	3	3						T			T	2		T	T	T	T
Alopecurus aequalis		T	T		T					T			T	T		T	T	T
Bromus tectorum			T	T		T	T				T		T	T	T	T	T	T
Carex douglasii		2	T	2							2	7	1	1		3	1	1
Carex lanuginosa									T			1			T	T	T	T
Carex nebrascensis					T							T		T		T	T	T
Carex spp.						1		5		3					2	T	T	T
Deschampsia spp.		T	T						T				T		T		T	T
Eleocharis palustris												T				T	T	T
Elymus cinereus		1	T	T						T	T		T	T		T	T	T
Elymus triticoides	T	1											T				T	T
Elymus spp.						T		T	T						T		T	T
Festuca idahoensis		4	2	1	T	T		T		1	T		2	T	T	T	1	T
Hordeum brachyantherum	6	5	T	1		T	1		T	4	1	T	4	T	T	2	2	2
Hordeum jubatum			28	6	T	4	3	2	9	18	12	5	9	3	4	12	8	7
Juncus balticus	2	2										T	1			T	T	T
Juncus drummondii	T	2								T	6	6	T			4	2	1
Juncus spp.			T										T				T	T
Koeleria nitida	T	3	4	1	T	2	9	6	4	2		T	2	T	5	T	3	3
Muhlenbergia richardsonis		2	T	T	2		1	2	4	1		T	T	1	2	T	1	1
Oryzopsis hymenoides	6	3	T	2					2	3			3	1	T	T	2	1
Panicum capillare				T	T	T				T				T	T	T	T	T
Phalaris arundinacea			T						T				T		T		T	T
Poa nevadensis	T	T	T	T						T	T		T	T		T	T	T
Poa sandbergii	4	6	3	4	T	6	5	7	10	5	7	7	5	2	7	6	6	6
Sitanion hystrix	4	1	3	3	6	5	6	5	5	1	1	T	3	4	5	1	4	4
Stipa thurberiana	16	19	25	24	38	33	53	38	49	28	29	30	20	31	43	29	37	32
Unknown grasses	1	4	T		T			T		T	T	T	2	T	T	T	T	T
Total Grasses	53	69	91	86	94	95	97	97	97	97	81	81	71	90	97	87	100	87
FORBS																		
Achillea lanulosa				1										T			1	T
Allium acuminatum				T										T			T	T
Allium parvum		T											T				T	T
Antennaria dimorpha		T											T				T	T
Arabis cobrensis		T											T				T	T
Arabis puberula								T							T		T	T
Arenaria aculeata	T	2		T						T			1	T		T	2	T

Appendix A-5. Continued

Species	1979						1980										% of Forage Class	% of Annual Diet
	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Summer	Fall	Winter	Spring		
Artemisia ludoviciana		T										T	T			T	T	T
Aster scopulorum	T										T	T	T			T	T	T
Astragalus curvicarpus		T										T	T			T	T	T
Astragalus malacus											1	2				1	2	T
Astragalus spp.			T		1		T						T	T	T		1	T
Balsamorhiza hookeri	3	3	1	2					T				2	T	T		6	T
Balsamorhiza sagittata	5	1									2	2	2			1	7	T
Camissonia tanacetifolia			T								T		T			T	T	T
Croton spp.								T							T		T	T
Cryptantha intermedia			T										T				T	T
Erigeron spp.	1	1	T	T	T	2	T	T			2	1	1	T	T	1	7	T
Eriogonum ovalifolium		T							T	T	T	T	T		T	T	2	T
Erodium cicutarium	T												T				T	T
Iris missouriensis			T										T				T	T
Leptodactylon pungens		T	T							T			T			T	1	T
Lesquerella kingii					T									T			T	T
Lupinus argenteus	2												T				1	T
Lupinus lepidus	20	17	5	8					2	T	8	9	14	4	T	6	48	6
Machaeranthera canescens												T				T	T	T
Oenothera spp.					T									T			T	T
Penstemon speciosus		T			T								T	T			T	T
Phlox hoodii	4	2	T		T	2	T	T			T	T	2	T	T	T	7	T
Phlox longifolia				1										T			T	T
Potentilla rivularis	6	1									3	1	2			2	8	1
Senecio canus	T	T		T									T	T			1	T
Taraxacum officinale							T	T							T		T	T
Trifolium gymnocarpon	T			T								T	T	T		T	T	T
Total Forbs	44	30	8	14	4	4	1	2	3	1	18	18	28	9	3	12	100	12
SHRUBS																		
Amelanchier utahensis		T											T				4	T
Artemisia arbuscula			T								T		T			T	6	T
Cercocarpus ledifolius		T				T	T						T		T		17	T
Chrysothamnus nauseosus			T										T				4	T
Chrysothamnus viscidiflorus	T											T	T			T	23	T
Grayia spinosa	T	T											T				17	T
Purshia tridentata	1												T				28	T
Total Shrubs	3	1	T	0	0	T	T	0	0	0	T	T	1	0	T	T	100	T
Unknown Shrub or Forb	0	0	T	0	2	1	2	1	0	2	1	1	T	1	1	1		1

Appendix B. Dietary breadth of mule deer, pronghorn antelope, bighorn sheep, domestic cattle, and feral horses on Sheldon National Wildlife Refuge, Nevada, 1979 and 1980.

	1979						1980										
Species	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Summer	Fall	Winter	Spring	Annual
Deer	1.3	1.1	1.2	1.3	1.3	0.9	1.1	1.0	1.1	1.0	1.2	1.2	1.2	1.3	1.1	1.2	1.3
Antelope	1.0	1.0	0.8	1.0	0.8	0.9	1.1	1.0	1.2	0.6	0.9	1.0	1.0	1.0	1.2	0.9	1.2
Sheep	1.2	1.3	1.4	1.3	1.1	1.2	1.2	1.2	1.2	1.3	1.4	1.4	1.4	1.2	1.3	1.5	1.5
Cattle	1.1	1.1	0.7	1.0	1.1	1.0	NO DATA				1.0	1.0	1.1	1.0	1.0	1.0	1.1
Horse	1.2	1.2	0.9	0.9	0.5	0.6	0.6	0.7	0.8	0.8	0.9	1.0	1.2	0.8	0.7	1.0	1.0

Appendix C. Similarity of diets of mule deer, pronghorn antelope, bighorn sheep, domestic cattle and feral horses on Sheldon National Wildlife Refuge, Nevada, 1979 and 1980.

	1979						1980						Summer	Fall	Winter	Spring	
Comparison	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July, Aug, Sep	Oct, Nov	Dec Jan, Feb, Mar	Apr, May, June	Annual
Deer – Antelope	41	57	54	56	44	52	49	68	65	62	54	56	54	54	71	64	76
– Deer	34	33	40	30	30	38	34	38	46	25	40	42	40	33	43	43	49
– Cattle	12	15	6	8	21	3	NO DATA				9	9	13	16	13	10	16
– Horses	12	6	4	7	5	T	3	5	8	3	5	5	8	8	5	5	11
Antelope – Sheep	29	32	33	22	15	32	35	39	50	17	20	32	37	19	44	30	47
– Cattle	7	10	3	3	5	4	NO DATA				4	9	7	5	15	6	12
– Horses	18	4	2	2	2	4	4	4	12	2	3	4	10	4	7	4	10
Sheep – Cattle	31	42	31	52	72	54	NO DATA				10	17	42	70	58	18	52
– Horses	16	28	20	23	39	19	30	25	25	15	7	5	25	33	26	11	28
Horses – Cattle	33	44	41	44	34	34	NO DATA				32	36	41	42	35	36	43

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